Electronic Noses and Breath Profiles for Diagnosing Disease

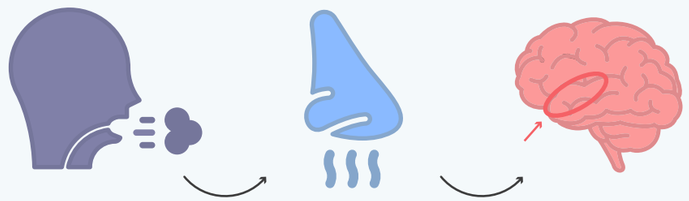
EMJ Innov. 2025; https://doi.org/10.33590/emjinnov/LVRK4878

EMJ European Medical Journal

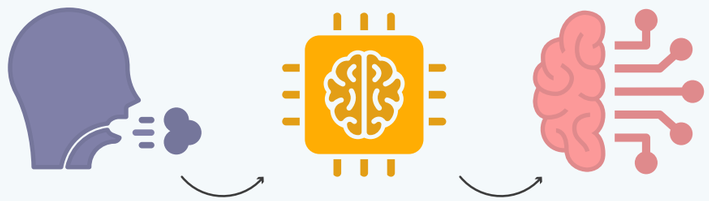
Electronic Noses for Diagnosing Disease

- A single breath contains hundreds of different VOCs.[1,2]
- Changes in the composition of VOCs in breath occurs during many diseases.[1,2]
- eNoses can detect disease biomarkers by identifying VOC patterns in breath and other excretions.[1,2]
- eNoses have three main parts: a sensor array, a data processing system, and a data interpretation system (pattern recognition algorithms and AI models).[1]
- Sensors act as the olfactory receptors, the data processor acts as the olfactory bulb, and the data interpretation system acts as the olfactory cortex.[3]

The Human Olfactory System



The Electronic Nose



Disease-Specific Breath and eNose Applications in Human Studies

COVID-19

- The breath profile of patients with **COVID-19** is different from healthy individuals, and thus can be detected using eNose technology.[4]
- In a recent study, eNose was able to differentiate between **COVID-19** and controls shortly after hospitalisation.[4]

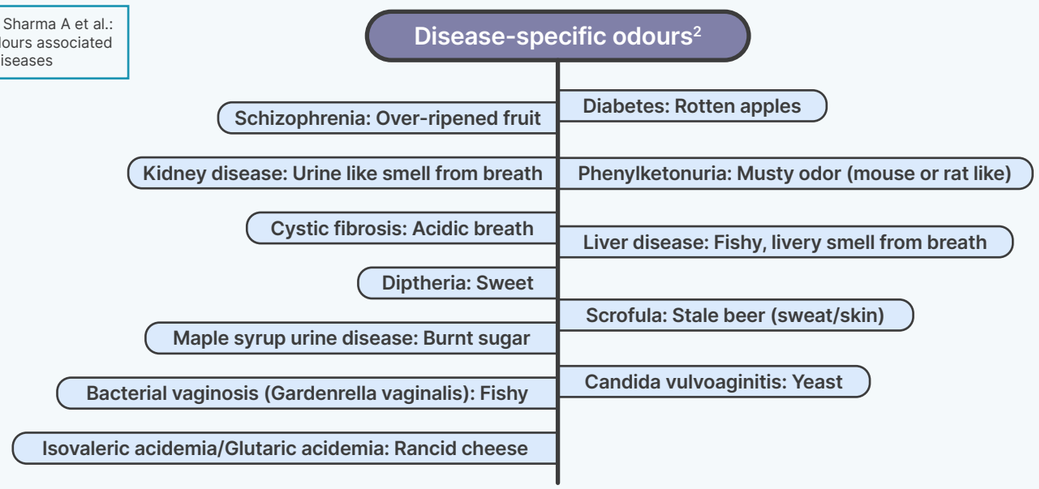
Cancer

- **Lung cancer**: In a Phase IIc trial of patients with Stage I Lung Cancer, eNose accurately identified the malignancy of nodules in **86% of cases**.[5]
- **Prostate cancer**: eNose with urine odour demonstrated strong accuracy in predicting **prostate cancer risk**, particularly when distinguishing low- versus high-/intermediate-risk patients.[6]

Neurological

- **Alzheimer's disease**: The analysis of breath samples from patients with AD and healthy individuals revealed **24 VOCs** in varying concentrations.[7]
- **Parkinson's disease**: In breath, alkanes and methylation alkanes were detected in higher concentrations, while styrene was found in higher concentrations in both AD and PD.[7]

Adapted from Sharma A et al.: The breath odours associated with various diseases



Advantages[1]

- Noninvasive
- Ease of use and portability
- Rapid results and real-time monitoring
- Avoids the discomfort and embarrassment of blood and urine tests
- Usually does not require expensive components or skilled operators
- Low technical costs

Limitations

- Current lack of large-scale clinical data to validate findings[2]
- The drift phenomenon: the sensor response and pattern recognition algorithm deviate over time, leading to decreased accuracy[1]
- Not all trials so far have shown success. For example, standard VOC analysis techniques have a higher specificity in detecting colorectal cancer, than eNose, albeit with a similar sensitivity[8]

Future Directions

- Large-scale studies in real-world settings, and innovations in sensing materials and AI algorithms will improve the accuracy and utility of the eNose.[1,2,3]
- This will enhance the capabilities of the eNose to recognise specific disease odours, which will aid diagnosis, disease monitoring, and the development of personalised medicine.[1,2,3]
- VOCs are also emitted from blood, sweat, skin, vaginal secretions, faeces, cancerous cell culture, urine, and other body fluids; specialised eNoses for different body excretions may optimise diagnostics.[2]

References

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Abbreviations:

VOC: volatile organic compound.

eNose: electronic nose